Appendix 16
Geology, Minerals, Soils, and Paleontology Data

Contents

Appendix 16A
Soil Types within the Primary Study Area

APPENDIX 16A
Soil Types within the Primary Study Area

Table 16A-1
Soil Types within the Primary Study Area

Map Unit Name	Colusa County	Glenn County	Map Unit Description	K Factor*	Water Erosion Potential	Shrink/ Swell Potential	Corrosion of Steel Potential	Corrosion of Concrete Potential
Altamont and Millsholm soils		X	Composed of Altamont (50%) and Millsholm (35%). This map unit is on uplands. The parent material consists of residuum weathered from sedimentary rock. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is very low. There is no zone of water saturation within a depth of 72 inches.	.37	Moderate	Low	Moderate	Moderate
Alcapay clay	X		The Alcapay, clay component makes up 90 percent of the map unit. This map unit is on basin floors. The parent material consists of alluvium. The natural drainage class is somewhat poorly drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is moderate. A seasonal zone of water saturation is at 48 inches during January, February, March, April, and December.	.32	Moderate	High	High	Moderate
Altamont clay		X	The Altamont component makes up 85 percent of the map unit. Slopes This map unit is on uplands. The parent material consists of residuum weathered from sedimentary rock. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is moderate. There is no zone of water saturation within a depth of 72 inches.	.24	Low	High	High	Low

Table 16A-1
Soil Types within the Primary Study Area

Map Unit Name	Colusa County	Glenn County	Map Unit Description	K Factor*	Water Erosion Potential	Shrink/ Swell Potential	Corrosion of Steel Potential	Corrosion of Concrete Potential
Altamont silty clay	X		The Altamont, silty clay component makes up 85 percent of the map unit. This map unit is on hills. The parent material consists of residuum weathered from sandstone-shale. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is moderate. There is no zone of water saturation within a depth of 72 inches.	.24	Low	High	High	Moderate
Altamont soils		X	Composed of Altamont, clay, moderately deep to deep (60%) and Altamont, clay loam, moderately deep (30%). This map unit is on uplands. The parent material consists of residuum weathered from sedimentary rock. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is low. There is no zone of water saturation within a depth of 72 inches.	.24	Low	High	High	Low
*		X	Composed of Altamont (65%) and Contra Costa (25%). This map unit is on uplands. The parent material consists of residuum weathered from sedimentary rock. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is moderate. There is no zone of water saturation within a depth of 72 inches.	.32	Moderate	High	High	Moderate
Altamont-Gullied land complex		X	Composed of Altamont (40%) and Gullied land (40%). This map unit is on foothills. The parent material consists of residuum weathered from sedimentary rock. The natural drainage class is well drained. Water movement in the most restrictive layer is very low. Available water to a depth of 60 inches is moderate. There is no zone of water saturation within a depth of 72 inches.	.24	Low	High	High	Low

Table 16A-1
Soil Types within the Primary Study Area

Map Unit Name	Colusa County	Glenn County	Map Unit Description	K Factor*	Water Erosion Potential	Shrink/ Swell Potential	Corrosion of Steel Potential	Corrosion of Concrete Potential
Altamont-Nacimiento association		X	Composed of Altamont (65%) and Nacimiento (20%). This map unit is on uplands. The parent material consists of residuum weathered from sedimentary rock. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is moderate. There is no zone of water saturation within a depth of 72 inches.	.28	Low	High	High	Low
Altamont-Rocky gullied land complex		X	Composed of Altamont (50%), Gullied land (20%), and Rock outcrop (15%). This map unit is on uplands. The parent material consists of residuum weathered from sedimentary rock. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is low. There is no zone of water saturation within a depth of 72 inches.	.24	Low	High	High	Low
Altamont-Sehorn complex	X		Composed of Altamont, silty clay (45%) and Sehorn, silty clay (35%). This map unit is on hills. The parent material consists of residuum weathered from sandstone-shale. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is low. There is no zone of water saturation within a depth of 72 inches.	.43	High	High	High	Moderate
Ayar clay	X		The Ayar, clay component makes up 85 percent of the map unit. This map unit is on hills. The parent material consists of residuum weathered from sandstone, calcareous. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is high. There is no zone of water saturation within a depth of 72 inches.	.43	High	High	High	Moderate

Table 16A-1
Soil Types within the Primary Study Area

Map Unit Name	Colusa County	Glenn County	Map Unit Description	K Factor*	Water Erosion Potential	Shrink/ Swell Potential	Corrosion of Steel Potential	Corrosion of Concrete Potential
*	X		The Capay, clay loam makes up 90 percent of the map unit. This map unit is on basin floors. The parent material consists of alluvium. The natural drainage class is moderately well drained. Water movement in the most restrictive layer is low. Available water to a depth of 60 inches is high. A seasonal zone of water saturation is at 48 inches during January, February, March, April, and December.	.37	Moderate	High	High	Moderate
Capay clay	X	X	The Capay, clay component makes up 90 percent of the map unit. This map unit is on basin floors. The parent material consists of alluvium. The natural drainage class is moderately well drained. Water movement in the most restrictive layer is low. Available water to a depth of 60 inches is moderate. A seasonal zone of water saturation is at 48 inches during January, February, March, April, and December.	.37	Moderate	High	High	Moderate
Clear Lake clay	X		The Clear Lake, clay, occasionally flooded component makes up 90 percent of the map unit. This map unit is on basin floors. The parent material consists of alluvium. The natural drainage class is poorly drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is moderate. A seasonal zone of water saturation is at 48 inches during January, February, March, April, and December.	.43	High	High	High	Moderate
Columbia fine sandy loam		X	The Columbia component makes up 85 percent of the map unit. This map unit is on flood plains. The parent material consists of alluvium. The natural drainage class is moderately well drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches is moderate. A seasonal zone of water saturation is at 0 inches during January.	.32	Moderate	Low	Moderate	Low

Table 16A-1
Soil Types within the Primary Study Area

Map Unit Name	Colusa County	Glenn County	Map Unit Description	K Factor*	Water Erosion Potential	Shrink/ Swell Potential	Corrosion of Steel Potential	Corrosion of Concrete Potential
Contra Costa-Altamont association	X		Composed of Contra Costa, loam (55%) and Altamont, silty clay (35%). This map unit is on hills. The parent material consists of residuum weathered from sandstone-shale. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is low. There is no zone of water saturation within a depth of 72 inches.	.37	Moderate	High	High	Moderate
Corbiere silt loam	X		The Corbiere, silt loam component makes up 85 percent of the map unit. This map unit is on rims on basin floors. The parent material consists of alluvium. The natural drainage class is somewhat poorly drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is high. A seasonal zone of water saturation is at 24 inches during January, February, March, April, and December.	.43	High	Moderate	High	High
Corning clay loam	X		The Corning, clay loam component makes up 90 percent of the map unit. This map unit is on terraces. The parent material consists of alluvium. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is moderate. There is no zone of water saturation within a depth of 72 inches.	.32	Moderate	Moderate	High	Moderate
Corval clay loam	X		The Corval, clay loam component makes up 85 percent of the map unit. This map unit is on alluvial fans, flood plains. The parent material consists of alluvium. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is high. There is no zone of water saturation within a depth of 72 inches.	.37	Moderate	Moderate	Moderate	Low

Table 16A-1
Soil Types within the Primary Study Area

Map Unit Name	Colusa County	Glenn County	Map Unit Description	K Factor*	Water Erosion Potential	Shrink/ Swell Potential	Corrosion of Steel Potential	Corrosion of Concrete Potential
Corval loam	X		The Corval, loam component makes up 85 percent of the map unit. This map unit is on flood plains, alluvial fans. The parent material consists of alluvium. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is high. There is no zone of water saturation within a depth of 72 inches.	.37	Moderate	Moderate	Moderate	Low
Hillgate clay loam	X	X	The Hillgate, clay loam component makes up 85 percent of the map unit. This map unit is on terraces. The parent material consists of alluvium. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is high. There is no zone of water saturation within a depth of 72 inches.	.28	Moderate	High	High	Moderate
Hillgate loam	X	X	The Hillgate, loam component makes up 90 percent of the map unit. This component is on terraces. The parent material consists of alluvium. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is high. There is no zone of water saturation within a depth of 72 inches.	.28	Moderate	Moderate	High	Moderate
Kimball gravelly loam		X	The Kimball component makes up 85 percent of the map unit. This map unit is on terraces. The parent material consists of alluvium. The natural drainage class is well drained. Water movement in the most restrictive layer is low. Available water to a depth of 60 inches is moderate. There is no zone of water saturation within a depth of 72 inches.	.20	Low	Moderate	Moderate	Moderate

Table 16A-1
Soil Types within the Primary Study Area

Map Unit Name	Colusa County	Glenn County	Map Unit Description	K Factor*	Water Erosion Potential	Shrink/ Swell Potential	Corrosion of Steel Potential	Corrosion of Concrete Potential
Mallard loam	X		The Mallard, loam component makes up 85 percent of the map unit. This map unit is on fans. The parent material consists of alluvium. The natural drainage class is somewhat poorly drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is high. A seasonal zone of water saturation is at 36 inches during January, February, March, April, and December.	.37	Moderate	Moderate	High	Moderate
Millsholm clay loam		X	The Millsholm component makes up 85 percent of the map unit. This map unit is on uplands. The parent material consists of residuum weathered from sedimentary rock. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is very low. There is no zone of water saturation within a depth of 72 inches.	.37	Moderate	Moderate	Moderate	Moderate
Millsholm rocky clay loam		X	Composed of Millsholm (60%) and Rock outcrop (30%). This map unit is on uplands. The parent material consists of residuum weathered from sedimentary rock. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is very low. There is no zone of water saturation within a depth of 72 inches.	.37	Moderate	Moderate	Moderate	Moderate
Millsholm rocky loam-Gullied land complex		X	Composed of Millsholm (40%), Rock outcrop (30%), and Gullied land (15%). This map unit is on uplands. The parent material consists of residuum weathered from sedimentary rock. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is very low. There is no zone of water saturation within a depth of 72 inches.	.37	Moderate	Low	Moderate	Moderate

Table 16A-1
Soil Types within the Primary Study Area

Map Unit Name	Colusa County	Glenn County	Map Unit Description	K Factor*	Water Erosion Potential	Shrink/ Swell Potential	Corrosion of Steel Potential	Corrosion of Concrete Potential
Millsholm very rocky loam		X	Composed of Millsholm (65%) and Rock outcrop (25%). This map unit is on uplands. The parent material consists of residuum weathered from sedimentary rock. The natural drainage class is somewhat excessively drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is very low. There is no zone of water saturation within a depth of 72 inches.	.24	Low	Low	Moderate	Moderate
Millsholm very rocky sandy loam		X	Composed of Millsholm (65%) and Rock outcrop (20%). This map unit is on uplands. The parent material consists of residuum weathered from sedimentary rock. The natural drainage class is somewhat excessively drained. Available water to a depth of 60 inches is very low. There is no zone of water saturation within a depth of 72 inches.	.15	Low	Low	Moderate	Moderate
Millsholm-Altamont complex	X		Composed of Millsholm, loam (60%) and Altamont, silty clay (25%). This map unit is on hills. The parent material consists of residuum weathered from sandstone-shale. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is very low. There is no zone of water saturation within a depth of 72 inches.	.37	Moderate	Low to High	High	Moderate
Millsholm-Altamont-Rock outcrop complex	X		Composed of Millsholm, loam (55%) and Altamont, silty clay (20%). This map unit is on hills. The parent material consists of residuum weathered from sandstone-shale. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is very low. There is no zone of water saturation within a depth of 72 inches.	.37	Moderate	Low to High	High	Moderate

Table 16A-1
Soil Types within the Primary Study Area

Map Unit Name	Colusa County	Glenn County	Map Unit Description	K Factor*	Water Erosion Potential	Shrink/ Swell Potential	Corrosion of Steel Potential	Corrosion of Concrete Potential
Millsholm-Capay complex	X		Composed of Millsholm, loam (50%) and Capay, clay (35%). The Millsholm, loam component makes up 50 percent of the map unit. This map unit is on hills. The parent material consists of residuum weathered from sandstone-shale. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is very low. There is no zone of water saturation within a depth of 72 inches.	.37	Moderate	Low to Very High	High	Moderate
Millsholm-Contra Costa association	X		Composed of Millsholm, loam (70%). This map unit is on hills. The parent material consists of residuum weathered from sandstone-shale. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is very low.	.37	Moderate	Low	High	Moderate
Millsholm-Contra Costa complex	X		Composed of Millsholm, loam (60%) and Contra Costa, loam (25%). This map unit is on hills. The parent material consists of residuum weathered from sandstone-shale. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is very low. There is no zone of water saturation within a depth of 72 inches.	.37	Moderate	Low to High	High	Moderate
Millsholm-Rock outcrop association	X		Composed of Millsholm, loam (50%) and Rock Outcrop (40%). This map unit is on hills. The parent material consists of residuum weathered from sandstone-shale. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is very low. There is no zone of water saturation within a depth of 72 inches.	.37	Moderate	Low	High	Moderate

Table 16A-1
Soil Types within the Primary Study Area

Map Unit Name	Colusa County	Glenn County	Map Unit Description	K Factor*	Water Erosion Potential	Shrink/ Swell Potential	Corrosion of Steel Potential	Corrosion of Concrete Potential
Millsholm-Rock outcrop complex	X		Composed of Millsholm, loam (55%) and Rock Outcrop (35%). This map unit is on hills. The parent material consists of residuum weathered from sandstone-shale. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is very low. There is no zone of water saturation within a depth of 72 inches.	.37	Moderate	Low	High	Moderate
Moonbend silt loam	X		The Moonbend, silt loam, occasionally flooded component makes up 80 percent of the map unit. This map unit is on flood plains. The parent material consists of alluvium. The natural drainage class is moderately well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is high. There is no zone of water saturation within a depth of 72 inches.	.43	High	Moderate	High	High
Myers clay loam		X	The Myers component makes up 85 percent of the map unit. This map unit is on alluvial fans. The parent material consists of alluvium derived from sedimentary rock. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is high. There is no zone of water saturation within a depth of 72 inches.	.28	Moderate	High	High	Moderate
Myers clay		X	The Myers component makes up 85 percent of the map unit. This map unit is on alluvial fans. The parent material consists of alluvium derived from sedimentary rock. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is moderate. There is no zone of water saturation within a depth of 72 inches.	.28	Moderate	High	High	Moderate

Table 16A-1
Soil Types within the Primary Study Area

Map Unit Name	Colusa County	Glenn County	Map Unit Description	K Factor*	Water Erosion Potential	Shrink/ Swell Potential	Corrosion of Steel Potential	Corrosion of Concrete Potential
Myers-Gullied land complex		X	Composed of Myers (40%) and Gullied land (40%). This map unit is on alluvial fans. The parent material consists of alluvium derived from sedimentary rock. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is high. There is no zone of water saturation within a depth of 72 inches.	.28	Moderate	High	High	Moderate
Nacimiento clay		X	The Nacimiento component makes up 85 percent of the map unit. This map unit is on foothills. The parent material consists of residuum weathered from sedimentary rock. The natural drainage class is well drained. Water movement in the most restrictive layer is very low. Available water to a depth of 60 inches is moderate. There is no zone of water saturation within a depth of 72 inches.	.28	Moderate	High	High	Low
Nacimiento soils		X	Composed of Nacimiento, clay, moderately deep and deep (60%) and Nacimiento, clay loam (30%). This map unit is on foothills. The parent material consists of residuum weathered from sedimentary rock. The natural drainage class is well drained. Water movement in the most restrictive layer is very low. Available water to a depth of 60 inches is moderate. There is no zone of water saturation within a depth of 72 inches.	.28	Moderate	High	High	Low
Nacimiento-Contra Costa association		X	Composed of Nacimiento (50%) and Contra Costa (30%). This map unit is on foothills. The parent material consists of residuum weathered from sedimentary rock. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is low. There is no zone of water saturation within a depth of 72 inches.	.32	Moderate	High	High	Moderate

Table 16A-1
Soil Types within the Primary Study Area

Map Unit Name	Colusa County	Glenn County	Map Unit Description	K Factor*	Water Erosion Potential	Shrink/ Swell Potential	Corrosion of Steel Potential	Corrosion of Concrete Potential
Nacimiento-Gullied land complex		X	Composed of Nacimiento (40%) and Gullied land (40%). This map unit is on foothills. The parent material consists of residuum weathered from sedimentary rock. The natural drainage class is well drained. Water movement in the most restrictive layer is very low. Available water to a depth of 60 inches is low. There is no zone of water saturation within a depth of 72 inches.	.28	Moderate	High	High	Low
Riz silt loam		X	This map unit is on basin floors. The parent material consists of alluvium derived from sedimentary rock. The natural drainage class is poorly drained. Water movement in the most restrictive layer is low. Available water to a depth of 60 inches is moderate. A seasonal zone of water saturation is at 42 inches during January, February, March, April, May, June, July, August, September, October, November, and December.	.43	High	Moderate	High	Moderate
Riz silty clay loam		X	This map unit is on basin floors. The parent material consists of alluvium derived from sedimentary rock. The natural drainage class is poorly drained. Water movement in the most restrictive layer is low. Available water to a depth of 60 inches is moderate. A seasonal zone of water saturation is at 42 inches during January, February, March, April, May, June, July, August, September, October, November, and December.	.43	High	Moderate	High	Moderate
Scribner, silt loam	X		The Scribner, silt loam, occasionally flooded component makes up 80 percent of the map unit. This map unit is on flood plains. The parent material consists of alluvium. The natural drainage class is poorly drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is high. A seasonal zone of water saturation is at 18 inches during January, February, March, April, and December.	.43	High	Low	Moderate	High

Table 16A-1
Soil Types within the Primary Study Area

Map Unit Name	Colusa County	Glenn County	Map Unit Description	K Factor*	Water Erosion Potential	Shrink/ Swell Potential	Corrosion of Steel Potential	Corrosion of Concrete Potential
Sehorn soils		X	Composed of Sehorn, clay (45%) and Sehorn, clay loam (45%). This map unit is on foothills. The parent material consists of residuum weathered from sedimentary rock. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is low. There is no zone of water saturation within a depth of 72 inches.	.32	Moderate	High	High	Low
Sehorn-Gullied land complex		X	Composed of Sehorn (45%) and Gullied land (45%). This map unit is on foothills. The parent material consists of residuum weathered from sedimentary rock. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is low. There is no zone of water saturation within a depth of 72 inches.	.28	Moderate	High	High	Low
Sehorn-Millsholm association		X	Composed of Sehorn (50%) and Millsholm (40%). This map unit is on foothills. The parent material consists of residuum weathered from sedimentary rock. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is low. There is no zone of water saturation within a depth of 72 inches.	.37	Moderate	Moderate to High	High	Moderate
Sehorn-Millsholm-Gullied land complex		X	Composed of Sehorn (30%), Millsholm (30%), and Gullied land (30%). This map unit is on uplands. The parent material consists of residuum weathered from sedimentary rock. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is very low. There is no zone of water saturation within a depth of 72 inches.	.37	Moderate	Moderate to High	High	Moderate

Table 16A-1
Soil Types within the Primary Study Area

Map Unit Name	Colusa County	Glenn County	Map Unit Description	K Factor*	Water Erosion Potential	Shrink/ Swell Potential	Corrosion of Steel Potential	Corrosion of Concrete Potential
Sehorn-Altamont complex	X		Composed of Sehorn, slity clay (45%) and Altamont, silty clay (35%). This map unit is on hills. The parent material consists of residuum weathered from sandstone-shale. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is low. There is no zone of water saturation within a depth of 72 inches.	.43	High	High	High	Moderate
Sehorn-Millsholm-Altamont complex	X		Composed of Sehorn, slity clay (40%), Millsholm, loam (30%) and Altamont, silty clay (30%). This map unit is on hills. The parent material consists of residuum weathered from sandstone-shale. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is low. There is no zone of water saturation within a depth of 72 inches.	.37	Moderate	Low to High	High	Moderate
Sehorn-Millsholm-Rock outcrop complex	X		Composed of Sehorn, slity clay (35%), Millsholm, loam (30%) and Altamont, silty clay (20%). This map unit is on hills. The parent material consists of residuum weathered from sandstone-shale. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is low. There is no zone of water saturation within a depth of 72 inches.	.37	Moderate	Low to High	High	Moderate
Tehama clay loam		X	The Tehama component makes up 85 percent of the map unit. This component is on terraces. The parent material consists of alluvium derived from metamorphic and sedimentary rock. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is high. There is no zone of water saturation within a depth of 72 inches.	.37	Moderate	Moderate	High	Low

Table 16A-1
Soil Types within the Primary Study Area

Map Unit Name	Colusa County	Glenn County	Map Unit Description	K Factor*	Water Erosion Potential	Shrink/ Swell Potential	Corrosion of Steel Potential	Corrosion of Concrete Potential
Vina Loam	X		The Vina, loam, frequently flooded component makes up 80 percent of the map unit. This map unit is on flood plains. The parent material consists of alluvium. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is high. There is no zone of water saturation within a depth of 72 inches.	.43	High	Low	Moderate	Low
Willows clay		X	The Willows component makes up 85 percent of the map unit. This map unit is on basin floors. The parent material consists of alluvium derived from sedimentary rock. The natural drainage class is poorly drained. Water movement in the most restrictive layer is low. Available water to a depth of 60 inches is moderate. A seasonal zone of water saturation is at 42 inches during January, February, March, April, May, June, July, August, September, October, November, and December.	.28	Moderate	High	High	Moderate
Willows, silty clay, slightly saline-alkali	X		The Willows, silty clay, frequently flooded component makes up 90 percent of the map unit. This map unit is on basin floors. The parent material consists of alluvium. The natural drainage class is poorly drained. Water movement in the most restrictive layer is low. Available water to a depth of 60 inches is moderate. A seasonal zone of water saturation is at 48 inches during January, February, March, April, and December.	.43	High	High	High	High
Yolo clay loam, moderately deep over clay		X	The Yolo component makes up 85 percent of the map unit. This map unit is on alluvial fans. The parent material consists of alluvium derived from sedimentary rock. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is high. There is no zone of water saturation within a depth of 72 inches.	.37	Moderate	High	Moderate	Low

Table 16A-1
Soil Types within the Primary Study Area

Map Unit Name	Colusa County	Glenn County	Map Unit Description	K Factor*	Water Erosion Potential	Shrink/ Swell Potential	Corrosion of Steel Potential	Corrosion of Concrete Potential
Yolo clay loam, shallow over clay		X	The Yolo component makes up 85 percent of the map unit. This map unit is on alluvial fans. The parent material consists of alluvium derived from sedimentary rock. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches is high. There is no zone of water saturation within a depth of 72 inches.	.37	Moderate	High	Moderate	Low
Zamora silty clay loam		X	The Zamora component makes up 85 percent of the map unit. This map unit is on alluvial fans. The parent material consists of alluvium derived from sedimentary rock. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is high. There is no zone of water saturation within a depth of 72 inches.	.37	Moderate	Moderate	High	Low

Source: The NRCS has mapped 61 soil types within the Primary Study Area. Table 16A-1 provides the soil map unit name, the county in which it occurs, a map unit description, and several soil properties, such as erosion potential, shrink/swell potential, corrosion of steel potential, and corrosion of concrete potential. Soil property values were derived using the NRCS Soil Data Viewer software.

*Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and saturated hydraulic conductivity (Ksat). Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Appendix 16B
Colusa County Fossil Sites

APPENDIX 16B
Colusa County Fossil Sites

Table 16B-1
Colusa County Fossil Sites
UCMP Database

Location ID Number	Locality Name	Period	Epoch	UCMP	No. Specimens	Near Project Site
12717	Funks Creek	Cretaceous	Late Cretaceous	M	3	Yes
12718	Funks Creek	Cretaceous	Late Cretaceous	M	6	Yes
12719	Salt Creek	Cretaceous	Late Cretaceous	M	4	No
12720	Salt Creek	Cretaceous	Late Cretaceous	M	2	No
12727	Salt Creek	Cretaceous	Late Cretaceous	M	2	No
12728	Salt Creek	Cretaceous	Late Cretaceous	M	2	No
12729	Salt Creek	Cretaceous	Late Cretaceous	M	5	No
12730	Salt Creek	Cretaceous	Late Cretaceous	M	5	No
12731	Salt Creek	Cretaceous	Late Cretaceous	M	1	No
12732	Salt Creek	Cretaceous	Late Cretaceous	M	2	No
12733	Funks Creek	Cretaceous	Late Cretaceous	M	4	Yes
12751	Funks Creek	Cretaceous	Late Cretaceous	M	3	Yes
36216	Wilbur Springs	Cretaceous		I	1	No
190-	Sand Creek	Cretaceous		I	1	No
3888-	Cache Creek	Cretaceous	Late Cretaceous	I		No
4228-		Cretaceous	Late Cretaceous	I		Unknown
A1065	Sulphur Creek	Jurassic		I		No
A1312	Corral Hollow Ranch	Tertiary	Eocene	I	2	Unknown
A2543	Bear Creek	Jurassic		I		No
A2544	Bear Creek	Cretaceous	Early Cretaceous	I		No
A2545	Sulphur Creek	Jurassic		I		No
A2546		Cretaceous		I		Unknown
A4262	Peterson Ranch	Cretaceous	Early Cretaceous	I		No
A4263		Cretaceous	Early Cretaceous	I		Unknown
A4658		Cretaceous	Early Cretaceous	I		Unknown
A4853	Logan Ridge	Cretaceous	Late Cretaceous	I		Yes
A4892		Cretaceous	Late Cretaceous	I		Unknown
A4893		Cretaceous	Late Cretaceous	I		Unknown
A4987	Petersen Ranch	Cretaceous	Late Cretaceous	I	2	No
A4988	Petersen Ranch	Cretaceous	Late Cretaceous	IM		No
A6434		Cretaceous	Late Cretaceous	I		Unknown
A6435		Cretaceous	Early Cretaceous	I		Unknown
A6436		Cretaceous	Early Cretaceous	I		Unknown
A6453		Cretaceous	Late Cretaceous	I		Unknown
B6323		Cretaceous	Late Cretaceous	I		Unknown
B930		Tertiary	Pliocene	I		Unknown

Table 16B-1
Colusa County Fossil Sites
UCMP Database

Location ID Number	Locality Name	Period	Epoch	UCMP	No. Specimens	Near Project Site
D1918		Cretaceous	Early Cretaceous	I		Unknown
D2712		Jurassic		I		Unknown
D2713	Cache Creek	Jurassic?		I		No
D2714		Jurassic?		I		Unknown
D2715	Elgin Mine	Jurassic?		I		No
D2716	Sulphur Creek	Jurassic?		I		No
D2717	Sulphur Creek	Jurassic		I		No
D2718		Jurassic		I		Unknown
D2719	Bear Creek	Jurassic?		I		No
D2720		Jurassic?		I		Unknown
D2721		Jurassic?		I		Unknown
D2722		Cretaceous	Early Cretaceous	I		Unknown
D2723		Cretaceous		I		Unknown
D2724		Cretaceous	Early Cretaceous?	I		Unknown
D2725	Oil Seep Creek	Jurassic?		I	2	No
D2726	Oil Seep Creek	Jurassic?		I		No
D2727		Jurassic?		I		Unknown
D2728		Jurassic?		I		Unknown
D2729		Jurassic?		I		Unknown
D2730		Jurassic?		I		Unknown
D2732		Jurassic?		I		Unknown
D2733		Jurassic		I		Unknown
D2734		Jurassic?		I		Unknown
D2735		Jurassic?		I		Unknown
D2737		Jurassic?		I		Unknown
D2739		Cretaceous		I		Unknown
D2740		Cretaceous	Early Cretaceous	I		Unknown
D2741		Jurassic?		I		Unknown
D2742		Jurassic?		I		Unknown
D2743		Jurassic?		I		Unknown
D2744		Jurassic?		I		Unknown
D2745		Cretaceous?		I		Unknown
D2746		Jurassic?		I		Unknown
D2747		Jurassic		I		Unknown
D2748		Jurassic?		I		Unknown
D2749		Jurassic?		I		Unknown
D2750		Jurassic?		I		Unknown
D2751		Jurassic?		I		Unknown
D2752		Jurassic?		I		Unknown
D2753		Jurassic?		I		Unknown
D2754		Jurassic?		I		Unknown
D2756		Cretaceous	Early Cretaceous	I		Unknown

Table 16B-1
Colusa County Fossil Sites
UCMP Database

Location ID Number	Locality Name	Period	Epoch	UCMP	No. Specimens	Near Project Site
D2757		Jurassic		I		Unknown
D2758		Jurassic		I		Unknown
D2759		Jurassic		I		Unknown
D2760	Bear Creek Road	Jurassic?		I		No
D2761	Bear Creek Road	Jurassic		I		No
D2762	Bear Creek Road	Jurassic?		I		No
D2763	Bear Creek Road	Jurassic?		I		No
D2764	Bear Creek	Jurassic?		I		No
D2765	Bear Creek	Jurassic?		I		No
D2766	Bear Creek	Jurassic?		I		No
D2767	Bear Creek	Cretaceous, Jurassic?		I		No
D2768		Cretaceous?		I		Unknown
D2769	Bear Creek	Jurassic?		I		No
D2770	Sulphur Creek	Jurassic?		I		No
D2771		Jurassic?		I		Unknown
D2772		Cretaceous?		I		Unknown
D2773		Jurassic		I		Unknown
D2774		Cretaceous?		I		Unknown
D2775		Jurassic		I		Unknown
D2776		Cretaceous		I	3	Unknown
D2777		Jurassic?		I		Unknown
D2778		Cretaceous?		I		Unknown
D2779		Cretaceous?		I		Unknown
D2780		Jurassic?		I		Unknown
D2781		Jurassic?		I		Unknown
D2782		Cretaceous, Jurassic?		I		Unknown
D2783		Jurassic?		I		Unknown
D2784		Jurassic?		I		Unknown
D2785		Jurassic?		I	1	Unknown
D2786	Wilbur Springs Area	Cretaceous?		I		No
D2787		Cretaceous		I		Unknown
D2788		Jurassic?		I		Unknown
D2789		Jurassic?		I		Unknown
D2790		Cretaceous	Early Cretaceous?	I		Unknown
D2791		Jurassic?		I		Unknown
D6376		Cretaceous		I		Unknown
D6377		Jurassic		I		Unknown

Table 16B-1
Colusa County Fossil Sites
UCMP Database

Location ID Number	Locality Name	Period	Epoch	UCMP	No. Specimens	Near Project Site
D7293	Bear Creek	Jurassic		I	1	No
D8015		Cretaceous		I		Unknown
D8016		Cretaceous		I		Unknown
D8021	Logan Ridge	Cretaceous		I		Yes
D8022		Cretaceous		I		Unknown
D8023		Cretaceous		I		Unknown
D8024		Cretaceous		I		Unknown
IP10253	Sand Creek	Cretaceous	Late Cretaceous	I	1	No
IP12583		Cretaceous		I	1	Unknown
IP654	Knoxville-Colusa	Cretaceous	Early Cretaceous	I	4	Unknown
MF3539	Grapevine Creek	Cretaceous	Early Cretaceous	M	1	No
MF3540	Grapevine Creek	Cretaceous	Early Cretaceous	M	1	No
MF3541	Kupper's DF 3	Cretaceous	Late Cretaceous	M	1	Unknown
MF3542	Sand Canyon	Cretaceous	Late Cretaceous	M		Unknown
MF3543	Sand Canyon	Cretaceous	Late Cretaceous	M		Unknown
MF3544	Sand Canyon	Cretaceous	Late Cretaceous	M		Unknown
P427	Sulphur Creek	Jurassic		P		No
V3403	Salt Creek	Tertiary	Pliocene	V	1	No
V3509	Colusa 1	Tertiary	Pliocene	V		Unknown
V5249	Cortina Creek	Tertiary	Pliocene	V	1	No
V72240	Chamisal Creek	Tertiary	Pliocene	V	2	No
V75105	Colusa 2	Tertiary	Pliocene	V	1	Unknown
V81039	Sand Creek N	Tertiary	Pliocene	V	1	No

Source: University of California Museum of Paleontology (UCMP). n.d. University of California Museum of Paleontology (UCMP) Online Database. http://ucmpdb.berkeley.edu/loc.html.

Notes

I = Invertebrate fossil site
IM = Mixed invertebrate and microfossil site
M = Microfossil site (may include pollen)
P = Plant megafossil site
V = Vertebrate fossil site
? = Period or epoch identification is tentative

Yes = The fossil site is within 2 miles of the Project site
No = The fossil site is not within 2 miles of the Project site
Unknown = The distance between the fossil site and the Project site is unknown

Appendix 16C
Results of the Paleontological Resources Literature Review

APPENDIX 16C
Results of the Paleontological Resources Literature Review

The paleontological resources literature review included an examination of not only the general geological literature and studies of major stratigraphic units, but also of the minor formations, facies, and out-of-date nomenclature. This is because fossil records (particularly those of finds made in the early 20th century) are sometimes associated with geological units that are no longer recognized, or with units that are in local use only.

Older Rocks of the Great Valley Sequence

Generally, these marine units range from the Jurassic to Cretaceous (201.6 to 65.5 MYA) in age. Table 16C-1 presents the Cretaceous (145.5 to 65.5 MYA) rock units that are likely to be present within one mile of the Primary Study Area. The names of the geologic units within the Great Valley Sequence (GVS) have been revised numerous times in the past (for example, Dickinson, 1972; Rich, 1971; and Ingersoll, 1979); to ensure that all fossil sites within the Primary Study Area were located, each name utilized by paleontologists is included, including outdated and superseded names.

Table 16C-1
Cretaceous Stratigraphic Units Likely Present within One Mile of the Primary Study Area (strata are organized from oldest to youngest)

Boxer Formation: In the Primary Study Area, this formation consists predominantly of mudstone with silty sandstone. Antelope Valley in the vicinity of the proposed Sites Reservoir has been formed by erosion of the highly erodible mudstone of the Boxer Formation. The Boxer Formation includes the Fiske Creek, Julian Rocks, Brophy Canyon, and the informally named Antelope Shale formations. The Boxer Formation occurs just below the Venado Sandstone, and is Cenomanian in age (ca. 95 to 93.5 MYA).
Cortina Petrofacies or Formation: The Cortina Formation is composed of sandstone, siltstone, and minor conglomerate in the Primary Study Area. It includes the following:
Venado Sandstone Member: The Venado Sandstone Member includes shale and conglomerate, as well as sandstone. Mollusks, as well as microfossils, are known from this member in the southern North Coast Ranges, which indicate a late Cenomanian age for the unit (Oqvist, n.d.). In the vicinity of the proposed Sites Reservoir, the Venado Member is considered of basal (early) Turonian (on the order of 93.5 MYA). It is represented by silty sandstone with interbedded mudstone, occasionally in beds up to five feet thick. The Venado Formation represents a submarine fan system, with a rising sea level during its period of deposition. The ridge immediately to the east of Antelope Valley is formed by the Venado Sandstone above its contact with the more erodible mudstones of the Boxer Formation.
Yolo Member: The Yolo Member in some areas is primarily a massively bedded fine- to coarse-grained sandstone with local siltstone (Solano County, 2006), and in other areas, it is composed mainly of shales with sandstones (Oqvist, n.d.). The shales contain microfossils. Carbonaceous debris occurs as well, and the recovered microfossils indicate a Turonian age (ca. 93.5 to 89 MYA). Relatively frequent turbidity currents (essentially underwater mudflows) occurred on a submarine fan, forming the Yolo Formation (Oqvist, n.d.). Bedrock within the footprint of the existing Funks Reservoir is composed of mudstones of the Yolo Member.
Sites Member: Regionally, the Sites Member consists of greywacke, dark carbonaceous siltstone, shale, and sandstone. The unit is up to 6,000 feet thick and microfossils indicate a Coniacian age (ca. 89 to 85.8 MYA). The Sites Member is interpreted as representing the channelized area of a submarine fan system.
Funks Member. The Funks Member consists primarily of fine-grained sediment indicative of deep water; in some areas described as shales, and in other areas, it is described as mudstone and siltstone. Poorly sorted and mineralogically heterogeneous sandstone are also present (Solano County, 2006). An erosional surface is usually found at the contact between the Sites Member and the Funks Member. Of Coniacian age, the Funks Formation can be up to 1,500 feet thick (Oqvist, n.d.).

Table 16C-1
Cretaceous Stratigraphic Units Likely Present within One Mile of the Primary Study Area (strata are organized from oldest to youngest)

Rumsey Formation: It is unclear the extent to which the youngest Upper Cretaceous units may be represented in the Primary Study Area. The Santonian and Campanian units (85.5 to 70.6 MYA) are found farthest east. Therefore, they are more likely to be buried beneath the Cenozoic fill of the Sacramento Valley, and are unlikely to outcrop within one mile of any of the proposed project features.
Guinda Formation. Also known as the Guinda Sandstone member of the Rumsey Formation, it consists of sands, siltstones, and shales. Some sand bodies are more than 10 feet thick and are present laterally for more than 1,000 feet. Sediments associated with Bouma sequences (distinctive sedimentary structures helpful in determining the conditions in which the sediments were deposited) are not uncommon. Calcareous concretions (harder masses of sediment within the formation, composed primarily of calcium carbonate), many exceeding one yard in diameter, are common in the uppermost portions of the Guinda Formation. Siltstone and mudstone are most common to the north and south of the Primary Study Area, and are less common locally (Haggart and Ward, 1984).
Dobbins Shale and Forbes Formation. The uppermost portions of the Guinda Formation are represented by turbidite deposits (essentially deposits from underwater mudflows) over which lies the Dobbins Shale (Haggart and Ward, 1984), the first member of the Forbes Formation. Mudstones, many with fossils, characterize this unit. Sandstones of the Forbes Formation overlie the Dobbins Shale. It was a shallowing sea, consistent with the fossils found in the Forbes Formation.
Hoodoo Hills: Paleontological sites attributed to the Hoodoo Hills (Chuber, 1961) were also analyzed, but more recent stratigraphic interpretations place these sites in several different units from Coniacean through Campanian age (89.3 to 70.6 MYA). The stratigraphy of this unit is not considered further.

Pliocene and Older Quaternary Sediments

In contrast to the marine rocks of the GVS, the terrestrial sediments in the Primary Study Area are much younger (Pliocene [5.2 to 1.7 MYA] and Quaternary [1.7 MYA to present]). Miocene (ca. 16 to 14 MYA) volcanic rocks of the Lovejoy Formation are present in the Primary Study Area, but because igneous rocks such as these are not paleontologically sensitive, they will not be considered further[1]. Rock formations of later Pliocene to middle Quaternary age near the Primary Study Area are listed in Table 16C-2.

Table**16C-**2
Late Neogene and Older Quaternary Sediments Likely Present within One Mile of the Primary Study Area

Tehama Formation: The older valley fill of the Sacramento Valley consists of a 100- to 600-foot thick sequence of sandy silt, sand, and silty gravel of river origin (Wahrhaftig and Birman, 1965). It is generally found exposed on the flanks of the valley, elevated above the streams from the North Coast Ranges. The Tehama Formation is above the GVS in this area, with uplift in the North Coast Range, and sedimentation occurring in the Tehama Formation (Lettis and Unruh, 1991). The Putah Tuff Member is a short distance above the base of the Tehama Formation at the southeastern margin of the North Coast Ranges, and the slightly younger Nomlaki Tuff Member is at the base of the Tehama Formation along the northeastern margin of the ranges, indicating that uplift occurred from south to north along the eastern margin of the North Coast Ranges (Sarna-Wojcicki et al., 1991). Both the Putah and Nomlaki Tuffs are approximately 3.4 MYA, with the latter being approximately 75,000 years younger (Sarna-Wojcicki et al., 1991). The Nomlaki Tuff is widely exposed along the western margin of the Sacramento Valley, where it is near the base of the Tehama Formation. Approximately 1.25 MYA, deposition of the Tehama Formation abruptly ceased and streams began to cut into the Tehama Formation.
Red Bluff Formation: The Red Bluff Formation consists of highly weathered strongly reddened gravel- and cobble-rich alluvium lying above the Tehama Formation. The age of the Red Bluff Formation is constrained by the overlying Rockland ash (ca. 0.45 MYA), and the underlying Deer Creek basalt (ca. 1.08 MYA). Most workers now consider this to be the capping unit of the Tehama Formation.

[1] Airfall tuffs (volcanic ash that can settle rapidly and bury things intact), as well as some types of volcanically induced debris flows, can yield important paleontological specimens, but these types of igneous rocks are not present in the Primary Study Area.

In contrast to the numerous geologic units that represent the Cretaceous GVS, few named geological units span the last approximately six million years. The definitions have undergone considerable revision over the years, including the Red Bluff and the Victor formations. The records search using the UCMP database yielded one site record from the Victor Formation, and two for the Red Bluff Formation. These are older records from the early 20th Century that are considered to represent sites from what is now recognized as the Tehama Formation.

Middle to Late Quaternary Sediments

The middle to late Quaternary sediments are listed in Table 16C-3.Like the GVS, the names used to describe these units have been revised multiple times, and all names on record as having been used by paleontologists were included.

Table 16C-3
Middle to Late Quaternary Sediments Likely Present within One Mile of the Primary Study Area

Riverbank Formation: The Riverbank Formation consists of gravel, sand, and silt that were deposited during the middle Pleistocene (ca. 300,000 to 130,000 years before present [B.P.]). The deep soil that is typically developed on the Riverbank (and, therefore, formed after the unit was deposited) likely originated 130,000 to 80,000 B.P.; therefore, the upper Riverbank Formation must have formed earlier, between 180,000 to 130,000 B.P.
Modesto Formation: The Pleistocene-age Modesto Formation, named by Davis and Hall (1959), is composed of fine-grained alluvium, sandstone, and siltstone with lesser amounts of pebble to cobble conglomerate. These materials are generally less cemented than those comprising the Riverbank Formation. These beds are believed to represent deposition 80,000 to 10,000 B.P., although when these deposits were eroded from the mountains is open to debate (Marchand and Allwardt, 1981; Atwater et al., 1986). These older deposits are as young as early Holocene in age, based on radiocarbon dating (ca. 9,400 B.P.).
Unnamed Quaternary Alluvium and Basin Deposits: Many geological maps do not differentiate among younger surficial deposits, nor do they distinguish between latest Pleistocene (those exceeding 10,000 B.P. in age) and Holocene sediments (those less than 10,000 B.P.). The unnamed "Younger Quaternary" deposits in the vicinity of the foothills of the North Coast Ranges, frequently deposited between older terraces attributable to the Modesto or Riverbank formations, consist of alluvium that is largely post-Pleistocene. Closer to the center of the Sacramento Valley, these mix with geologic units mapped most frequently as "Basin Deposits." These are fine-grained fluvial sediments representing overbank floods intermixed with sands and gravels of the dominant stream channels.

References

Atwater, Brian F., David P. Adam, J. Platt Bradbury, Richard M. Forester, Robert K. Mark, William R. Lettis, G. Reid Fisher, Kenneth W. Gobalet, and Stephen W. Robinson. 1986. A fan dam for Tulare Lake, California, and implications for the Wisconsin glacial history of the Sierra Nevada. Geological Society of America Bulletin, v. 97, p. 97-109.

Chuber, S., 1961. *Late Mesozoic stratigraphy of the Elk Creek-Fruto area, Glenn County, California*. Ph.D. Thesis, Stanford University, Stanford, CA.

Davis, Stanley N. and Francis R. Hall. 1959. Water Quality of Eastern Stanislaus and northern Merced County, California. Stanford University Press. 112 p.

Dickinson, W.R. and E.I. Rich. 1972. Petrologic intervals and petrofacies in the Great Valley sequence, Sacramento Valley, California. *Geological Society of America Bulletin* 83: 3007-3024.

Haggart, J.W., and P.D. Ward. 1984. Late Cretaceous (Santonian-Campanian) stratigraphy of northern Sacramento Valley, California. *Geological Society of America Bulletin* 95: 618-627.

Ingersoll, R.V., 1979. Evolution of the Late Cretaceous forearc basin, northern and central California. *Geological Society of America Bulletin* 90: 813-826.

Lettis, W. R. and J. R. Unruh. 1991. Quaternary Geology of the Great Valley, California. *In* Morrison, Roger B., ed. *Quaternary Nonglacial Geology: Conterminous U.S.* Geological Society of America, 672 p.

Marchand, Denis E. and A. Allwardt. 1981. Late Cenozoic Stratigraphic Units, Northeastern San Joaquin Valley, California. United States Geological Survey. Geological Survey Bulletin 1470. 78 p.

Oqvist, C.R., n.d. *Surface and Bedrock Geology of the Stebbins Cold Canyon Reserve Area, Vaca Mountains, Solano County, California*. University of California, Davis. http://nrs.ucdavis.edu/stebbins/natural/geo_report.htm

Rich, E.I. 1971. *Geologic map of the Wilbur Springs Quadrangle, Colusa and Lake Counties, California.* Miscellaneous Geological Investigations Map I-538, U.S. Geological Survey, Menlo Park, CA.

Sarna-Wojcicki, A.M., and Davis, J.O., 1991, Quaternary Tephrochronology. In Morrison, R.B., ed., Quaternary nonglacial geology; Conterminous U.S., Boulder, Colorado, Geological Society of America, The Geology of North America, v. K-2, p. 93-116.

Solano County, 2006. *Solano County General Plan Update Cultural and Paleontological Resources Background Report*. Fairfield, CA.

University of California Museum of Paleontology (UCMP). n.d. *University of California Museum of Paleontology* (UCMP) *Online Database*. http://ucmpdb.berkeley.edu/loc.html.

Wahrhaftig, Clyde, and J.H. Birman. 1965. The Quaternary of the Pacific mountain system in California. In *The Quaternary of the United States*, edited by H. E. Wright, Jr., and D. G. Frey, pp. 299-340. Princeton University Press, New Jersey.